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NON-IDENTITY OF INERTIAL AND GRAVITATIONAL MASSES

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Only conditional identity of inertial mass of moving matter to its gravitational mass only by gravity-quantum clock, which is located in the point, from which the matter started its inertial motion, and due to the usage of corrected value of gravitational constant in its pseudo-centric intrinsic frame of reference of spatial coordinates and time (FR), is justified. This is related to the equivalence of inertial mass of matter to the Hamiltonian of its inert free energy, while the gravitational mass of matter is equivalent to the Lagrangian of its internal energy.

Keywords: gravithermodynamics, SR, GR, inert free energy.

In classical mechanics and in SR the inert free energy of rest $E_0=m_{in0}c^2=m_{00}cv_c$, which tends to the minimum and transforms into kinetic energy in the process of the fall of body in gravitational field, is the equivalent of Helmholtz and Gibbs free energies, which tend to the minimum in thermodynamic processes. The conservation of Hamiltonian of the inert free energy of rest of matter $\mathrm{H}\equiv m_{in}c^2=E\Gamma=m_{in0}c^2\Gamma=m_{00}cv_c(1-v^2v_c^{-2})^{-1/2}=\mathbf{const}(r)$ ($v_l\Gamma=\mathbf{const}(r)$) is guaranteed due to the decreasing of inertial mass of rest $m_{in0}=m_{00}v_c/c$ of matter in the process of its free fall. The Hamiltonian momentum $\mathrm{P_H}=-(\partial \mathrm{L}_{in}/\partial v)_{vc}=m_{00}c(v/v_c)(1-v^2v_c^{-2})^{-1/2}=m_{gr0}v\Gamma$, which is proportional to gravitational mass $m_{gr0}=m_{00}c/v_c$, is derived from Lagrangian $\mathrm{L}_{in}=E/\Gamma=m_{00}cv_c(1-v^2v_c^{-2})^{1/2}$ of namely inert free energy of matter. The magnitude of matter momentum, according to Noether's theorem [1] and Heisenberg uncertainty principle, is invariant (in relation to the transformation of time) characteristic of moving matter and, consequently, is invariant for all observers despite the different rates of time of their gravity-quantum clocks.

Coordinate pseudo-vacuum velocity of light $v_{cj}(r)=cb_j^{1/2}$ is determined for certain point j in unified (for all gravithermodynamically bonded matter of the Earth) coordinate astronomical time t_E. It is identical to the critical velocity of baryonic matter in the relativistic gravithermodynamics (RGTD) [2, 3] and its value depends on Schwarzschild radial coordinate r of that point. It decreases while approaching the pseudo-horizon or the gravity center. Gravity-quantum value of coordinate velocity of light: $^iv_{cj}=cv_{cj}/v_{ci}=c(v_{c0j}/v_{c0i})^{(c/v_{ci})^2}$ $\left[{}^ib_j=(b_{0j}/b_{0i})^{1/b_i}\right]$ is also dependent on coordinate velocity of light v_{ci} in the point i of disposition of real or prospective observer. Here v_{c0j} and v_{c0i} are the values of coordinate velocity of light in intrinsic centric frames of references ${}^{ic}\mathrm{FR}_0$ of spatial coordinates and time of prospective observer. Metric eigenvalue of velocity of light is the spatio-temporal invariant (gauge-invariant and Lorentz-invariant constant) by intrinsic clock. This eigenvalue (proper value in Special Relativity) is equal to the constant of velocity of light in any point of space: $^iv_{ci}={}^jv_{cj}=c$.

Obviously, the momentum $\mathbf{P}_j=m_{00}v_jc(v_{cj}^2-v_j^2)^{-1/2}=\mathbf{inv}(t_i)$ of matter does not depend on the rate of gravity-quantum time, which is not equal in the points with different gravitational potential. Therefore, the values in FR of inertial and gravitational mass will be expressed via proper rest mass (eigenvalue of mass) m_{00} in the following way $m_{in0j}=m_{00}v_{cj}/c=m_{00}b_j^{1/2}$ and $m_{gr0j}=m_{00}v_{cj}/cb_j=m_{in0j}/b_j=m_{00}c/v_{cj}$. And their gravity-quantum values will be as follows: $^im_{in0j}=m_{00}c^{-2}v_{cj}v_{ci}=m_{00}c^{-2}v_{ci}^2(v_{c0j}/v_{c0i})^{(c/v_{ci})^2}=m_{00}b_i(b_{0j}/b_{0i})^{1/2b_i}$,
$^im_{gr0j}=m_{00}c/{}^iv_{cj}=m_{00}(v_{c0i}/v_{c0j})^{(c/v_{ci})^2}=m_{00}(b_i/b_j)^{1/2b_i}$. Obviously, proper rest mass m_{00} can be equal for homogeneous matter in gravitational field only in case of presence of its thermodynamic quasi-equilibrium.

As it was shown by Tolman [4] and as it follows from the Schwarzschild internal solution for incompressible ideal liquid [5], the gravitational forces in it are proportional to ordinary enthalpy $H_{T0}=U_0+pV=H_{T00}c/v_l$, (where: $H_{T00}=\mathbf{const}(r)$), which is not decreasing in contrast to inert free energy E, but, quite the contrary, is increasing while approaching the gravitational attraction center. And since for quasi-equilibrium cooling down matter $pV/U_0=\mathbf{const}(r)$, then the ordinary internal energy of rest $W_0\equiv U_0=U-U_{ad}=W_{00}c/v_l$ ($W_{00}=\mathbf{const}(r)$) of matter is also inversely proportional to coordinate velocity of light. Here p is the pressure, V is the molar volume, and $U_{ad}=\mathbf{consnt}(r)$ is the additive compensation of multiplicative decreasing (with time) of multiplicative component $W_0=m_{gr0}c^2=m_{00}c^3/v_c$ of internal rest energy U of matter.

And, consequently, it is quite obvious that inertial mass of moving matter is conventionally equivalent to its gravitational mass only by the intrinsic clock of the point, from which matter started its inertial motion, in case of the correction of the value of gravitational constant, which guarantees the conventional absence of bound energy of matter in centric or pseudo-centric intrinsic FR of matter. And this is related with the equivalence of inertial mass of matter to the Hamiltonian of its inert free energy, while the gravitational mass of matter is equivalent to the Lagrangian of its ordinary internal energy. And the ratio of these masses is invariant due to the conservation in time of Hamiltonians of inert free energy H and of Lagrangians of ordinary internal energy L of inertially moving gravity-quantum clock of observed matter and of observer:

$$m_{gr0}=m_{in0}\mathrm{H_i L_j}/\mathrm{L_i H_j}=m_{in0}v_{cri}^2v_{crj}^{-2}\equiv m_{in0}{}^iv_{lrj}^{-2}c^2=\mathbf{const}\ (t),$$

where: ${}^iv_{crj}\equiv{}^jv_{lrj}=cv_{lrj}/v_{lri}=(cv_{lj}/v_{li})(1-v_j^2v_{lj}^{-2})^{-1/2}(1-v_i^2v_{li}^{-2})^{1/2}$ is the value of limit velocity of matter motion in the points of its hypothetic rest relatively to hypothetic observer of the motion.

Of course, it could be assumed that such concept as Hamiltonian is excessive for GR and especially for RGTD. The conservation of Lagrangian of ordinary internal energy and the tendency to zero of the Lagrangian of inert free energy of matter take place in GR and RGTD. However, the usage of only Lagrangian does not allow to reflecting the reality using the local pseudo-Euclidean space-time. Moreover the decreasing ($m_{gr0}/m_{in0}=v_{lrj}^{-2}v_{lri}^2=c^2/{}^iv_{lr}^2=b_{ri}/b_{rj}$ times) of required average density of mass of astronomical objects in the galaxy will not be guaranteed. That is why we have to rely on namely this hypothesis.

Possibly we should also consider the mass only as the measure of quantity of matter, and we should characterize inertial and gravitational properties of matter by Hamiltonian of inert free energy and Lagrangian of ordinary internal energy of matter correspondingly.

Conclusion

It is quite obvious that inertial mass of moving matter is conventionally equivalent to its gravitational mass only by the intrinsic clock of the point, from which matter started its inertial motion, in case of the correction of the value of gravitational constant, which guarantees the conventional absence of bound energy of matter in centric or pseudo-centric intrinsic FR of matter.

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